INTRODUCTION TO STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

Submitted by

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Section A

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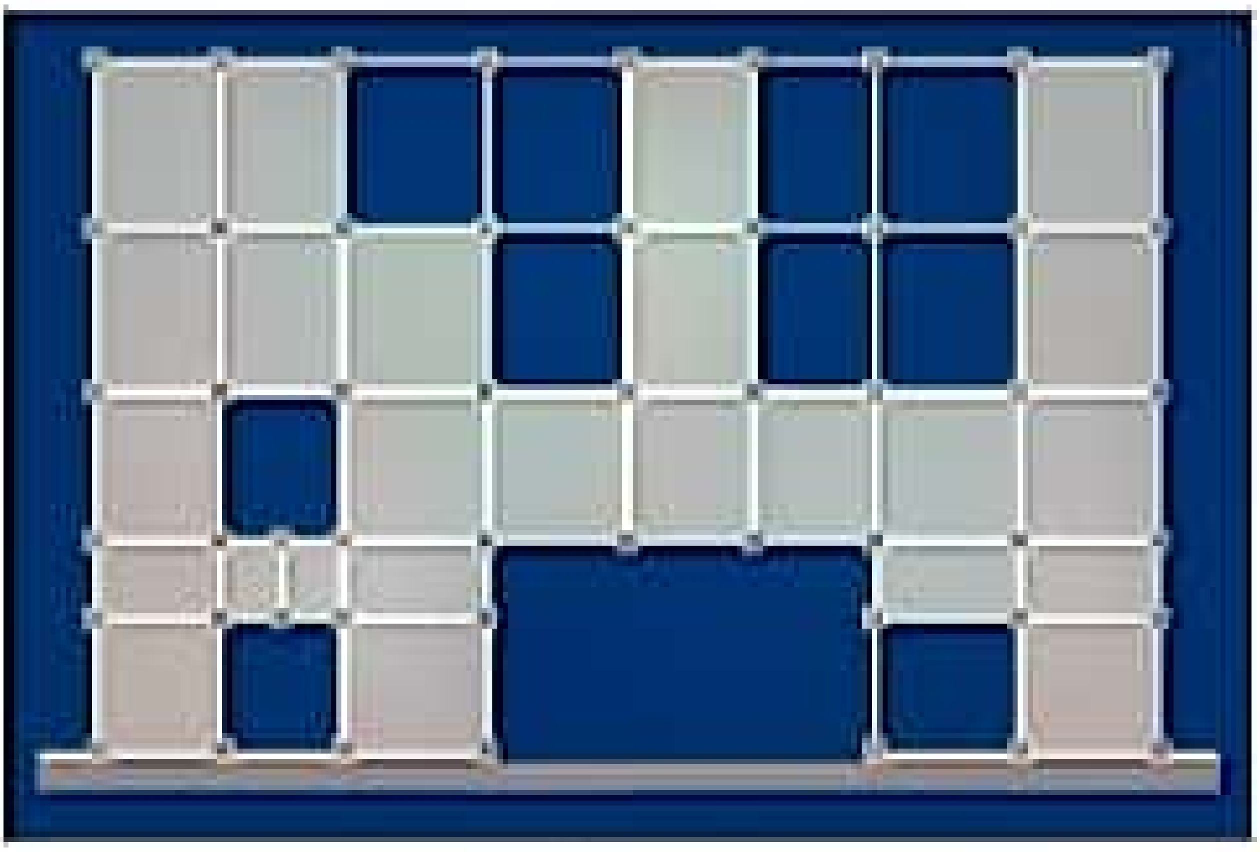


Figure 1

Type of Configuration:-

The type of verious configuration condition which is shown in the figure is Discontinous shear walls.

Purpose of the Shear Wall:-

The Purpose of the shear-wall is to collect the diaphragm loads at each floor and transmit them as directly and efficiently to the foundation.

Effect of Discontinuity In Shear Wall:-

When there is discontinuity in shear walls, so the lateral forces, which are caused by earthquake, produces powerful torsion and hence increases the chances of collapse.

When all the stories of all the building does not contain the shear, It mean discontinuity in shear walls so it directly indicates that there is no continous load pattern from roof to the foundation because of absence of shear wall and the result of this can be so serious at point of discontinuity during an earthquake and can create damages.

Possible solutions:-

(1) **Eliminate The shear-wall:-**

One of the possible solution to this problem is to elimante the shear-walls so as to avoid the sesmic affects of discontinuity of shear-walls.

(2) **Provide shear-walls in all stories:-**

Another solution to this problem is to provide the shear-walls in all stories of the building, so that there is no discontinuity in shear-walls and there is a continous load path from roof to foundation.

(3) **Careful Architectural And Engineering Consideration:-**

If the decision is made to use the shear-walls then their presence must be recognized from the begining of schematic design and their size and location made the subject of careful architectural and engineering coordination in early stages of Design.

(4) **Prevents Rotation at Joints:-**

Another possible solution is to reinforcing a frame by attaching or placing a rigid wall inside it, maintains the shape of the frame and thus prevents rotation at the joints and hence elimantes seismic danger effects.

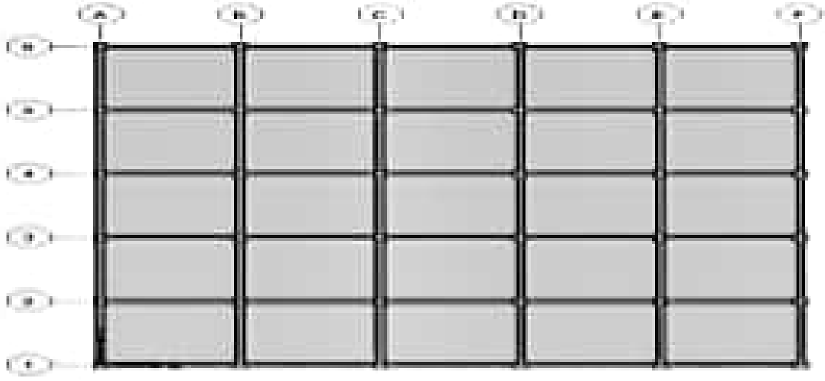


Fig. 1. The Building without shear wall

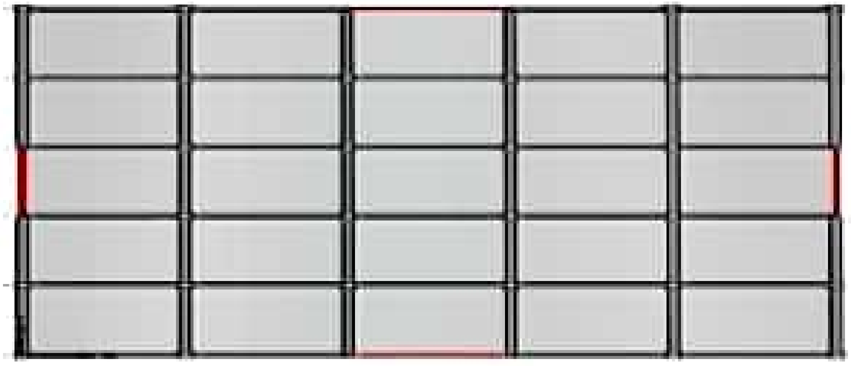


Fig. 2. The building with shear walls one on each side at centre

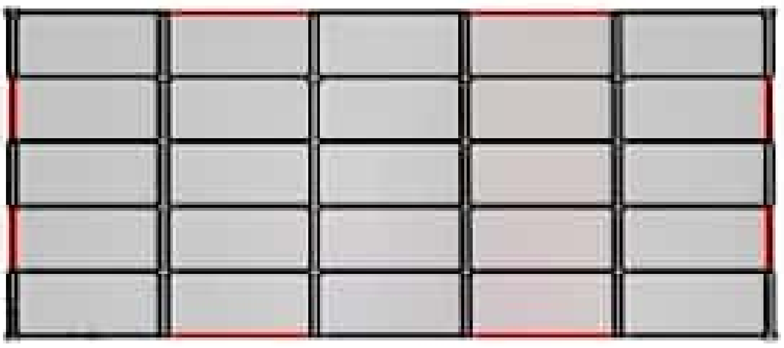


Fig. 3. The building with shear walls alternatively on each side

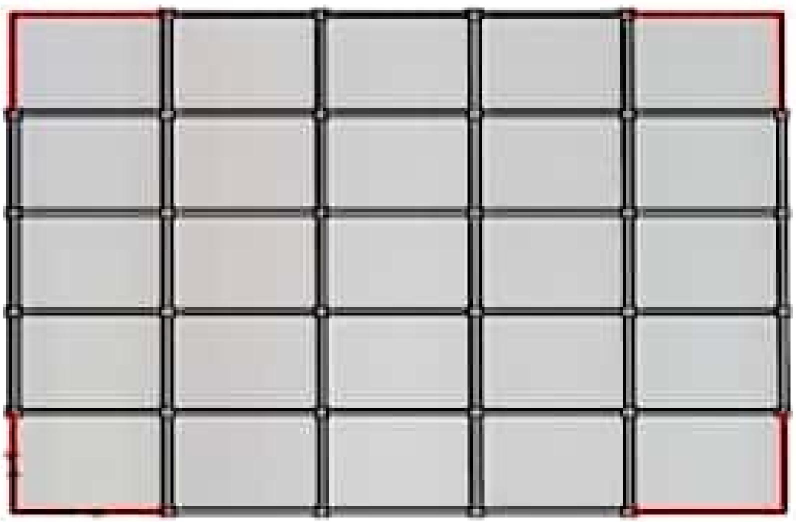


Fig. 4. The building with shear walls at corners on each side

Figure 2

Type of Configuration:-

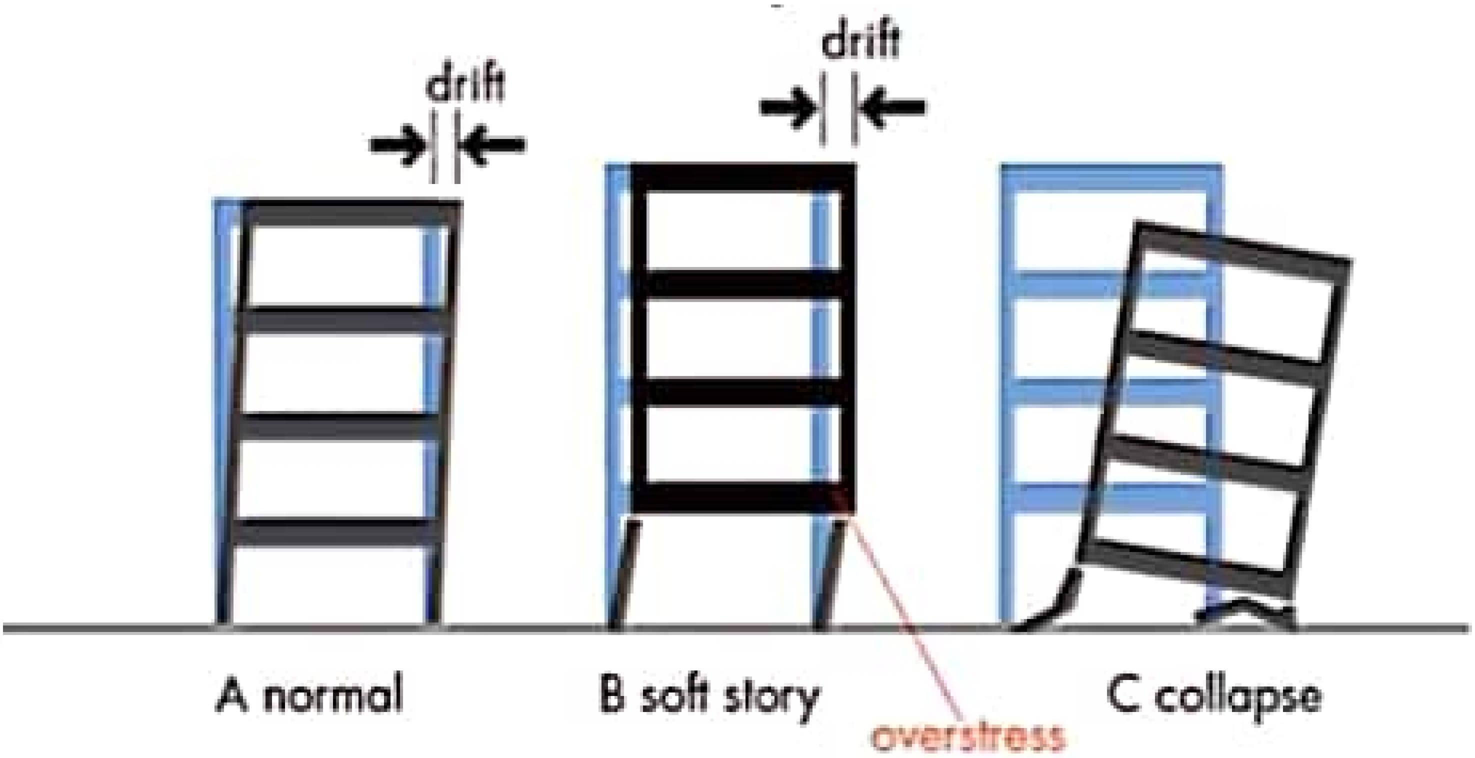
The type of serious configuration condition which is shown in figure is soft and weak storey.

Soft and Weak story:-

The building in which the stiffness and strength of the lower story is less as compare to all the above stories, this phenomenon is called soft and weak story.

Effect:-

The presence of walls in the upper storey make them much stiffer then the lower storey. Thus the upper stories moves almost together as a single block and the lower soft story moves seperate during an earthquake and as a result the soft storey will collapse.



The soft first story failure mechanism.

Possible Solutions:-

Some of the possible solution to overcome the effects of earthquake on soft-story are as given bellow:-

(1) **Add coloumns:-**

One of the possible solution is to provide more coloumns in order to achieve the required strength and to increase the stiffness to overcome the soft storey configuration condition.

(2) **Add Bracing:-**

Add bracing to the soft storey of the building.

(3) **Add External Buttresses:-**

Adding external Buttresses to soft storey is another solution.

(4) **Specific Design Consideration:-**

Another possible solution is to specifically design the first storey for much larger loads and smaller induced displacements then then the rest of the structure

Solutions

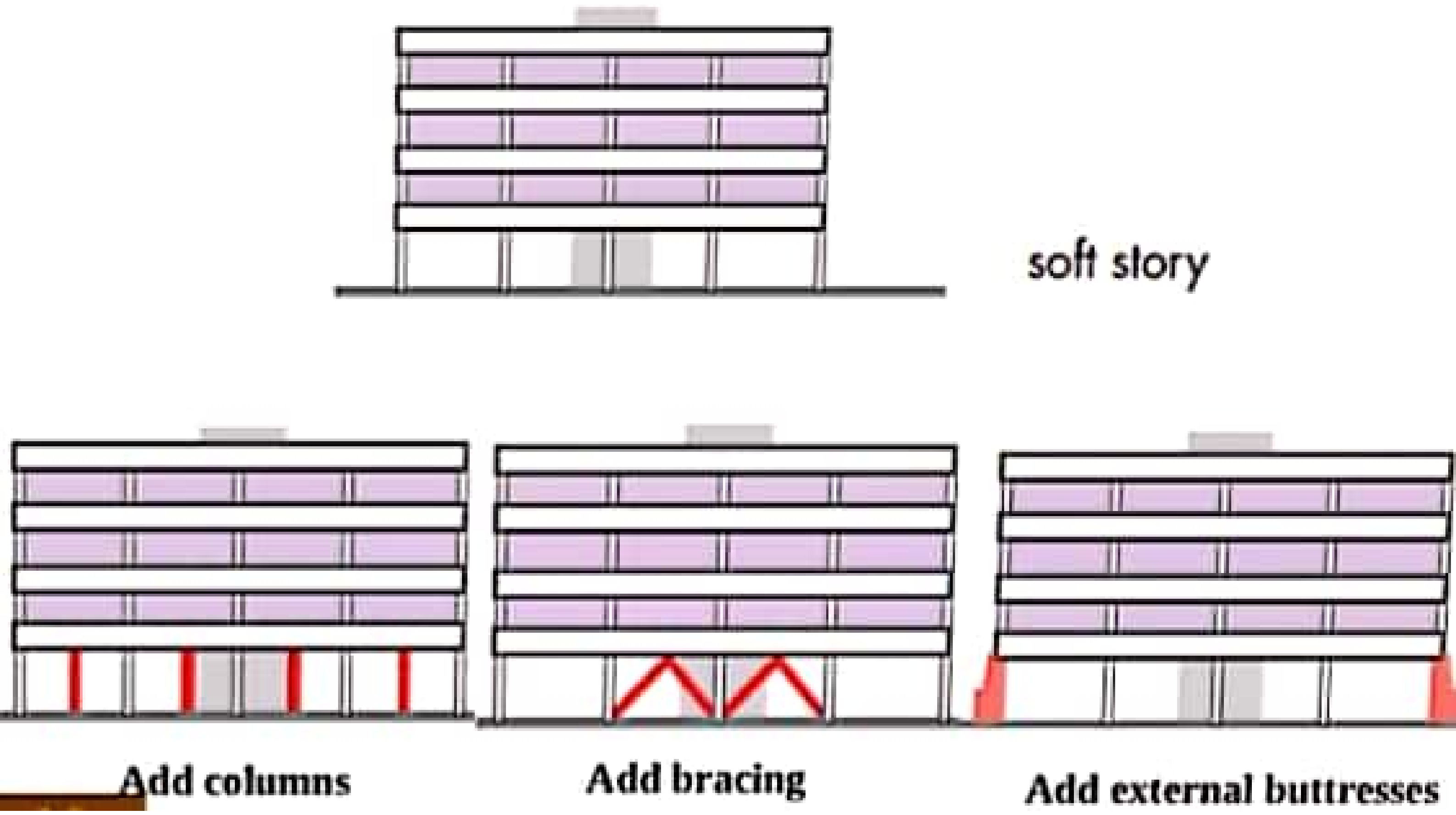

soft story
Add columns
Add bracing
Add external buttresses

Figure 3

Type of Configuration:-

The type of configuration condition shown in the figure is ;
Re-entrant corners.

Re-entrant corners:-

The re-entrant corner is the common characteristic of building forms that in plan, assume the shape of an L, T, H etc.... or a combination of these shapes.

Re-entrant corner plan forms.

Effects of Re-entrant corners:-

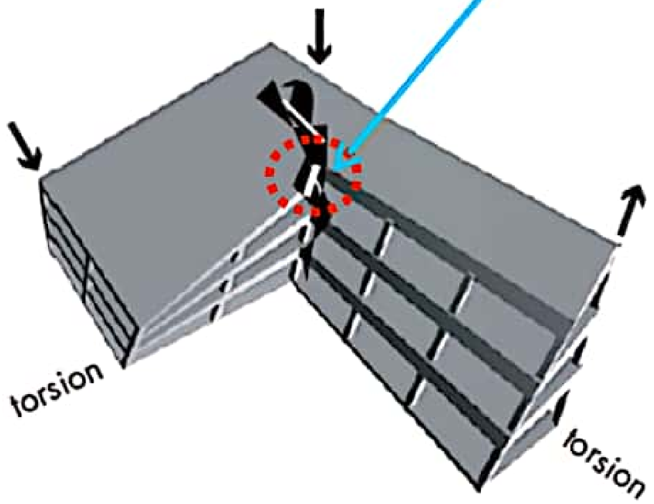
There are two problems caused by the Re-entrant corners:

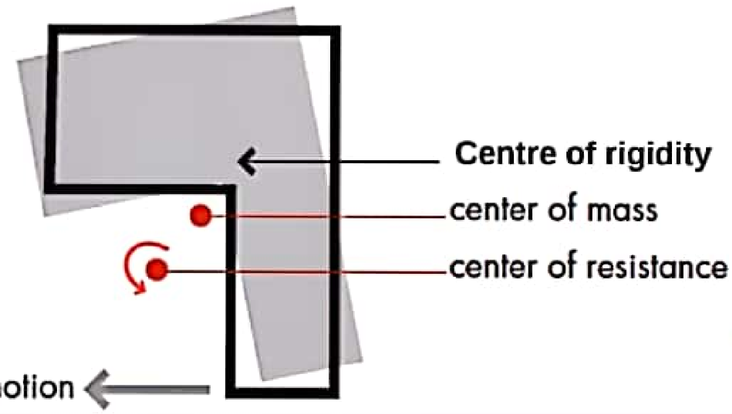
(a) **Differential Motion:-**

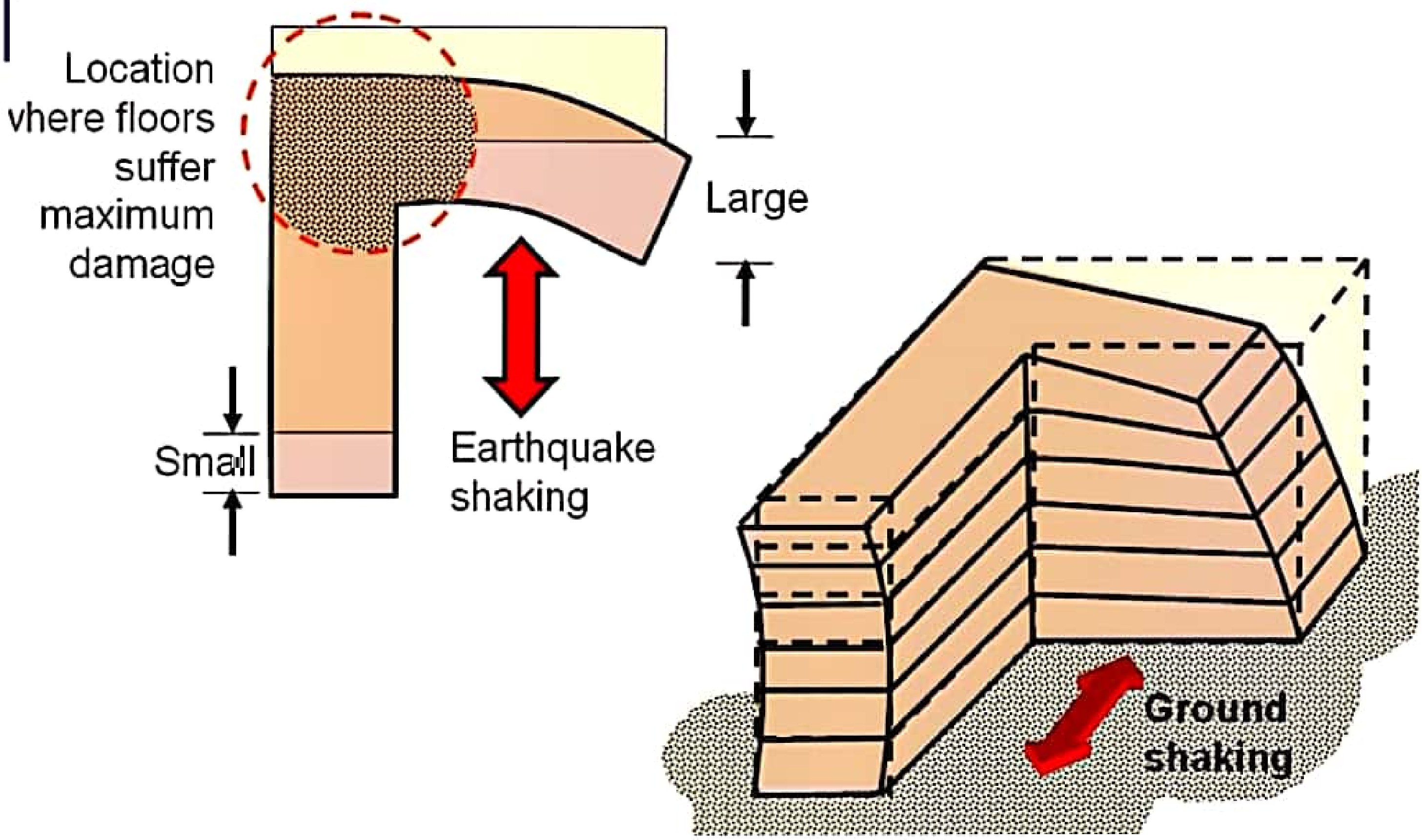
Structure consisting of re-entrant corners tends to produce differential motions between different wings of the building, because of stiff elements that tends to be located in this regions, result in local stress concentrations at re-entrant corners.

(b) **Torsion:-** The second Problem to the effect of re-entrant corner is torsion. Torsion is caused because the center of mass and the center of rigidity in this form cannot geometrically coincide for all possible earthquake directions. The result is rotation, the resulting force are very difficult to analyze and predict.

Re-entrant Corners







Differential deformation at the junction of two wings

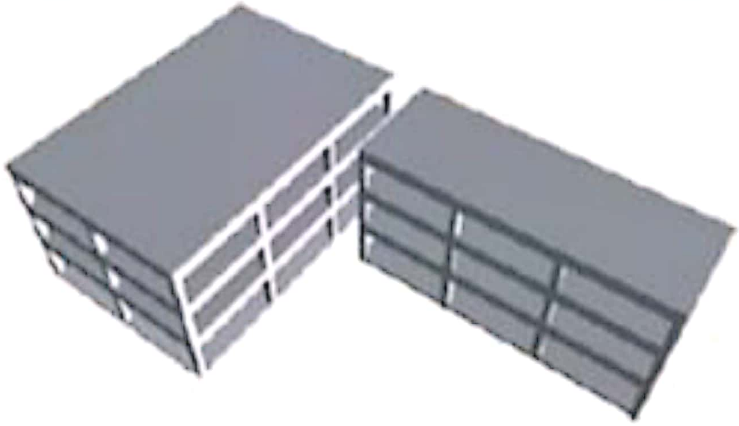
Possible Solution:-

The possible solution to eliminate the effects of Re-entrant corners are as follows;

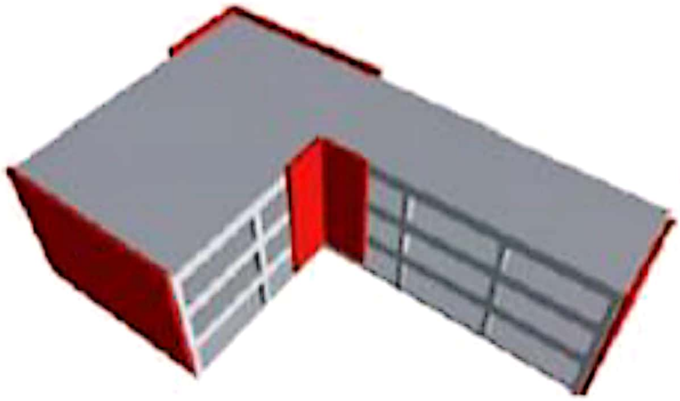
(1) **Seperate the building into Simpler shapes:-** One of the possible solution is to structurally seperate the building into simpler shapes, so that to avoid the stress concentration at corners and also to avoid the crack formation so that to reduce the torsion effects. In case of seperation building must be sufficiently away to ensure they do not pound together and damage each other in an earthquake.

(2) **To tie the building:-** Another possible solution is to tie the building together more strongly with elements positioned to provide a more balanced resistance. But this type of solution applies only to smaller buildings.

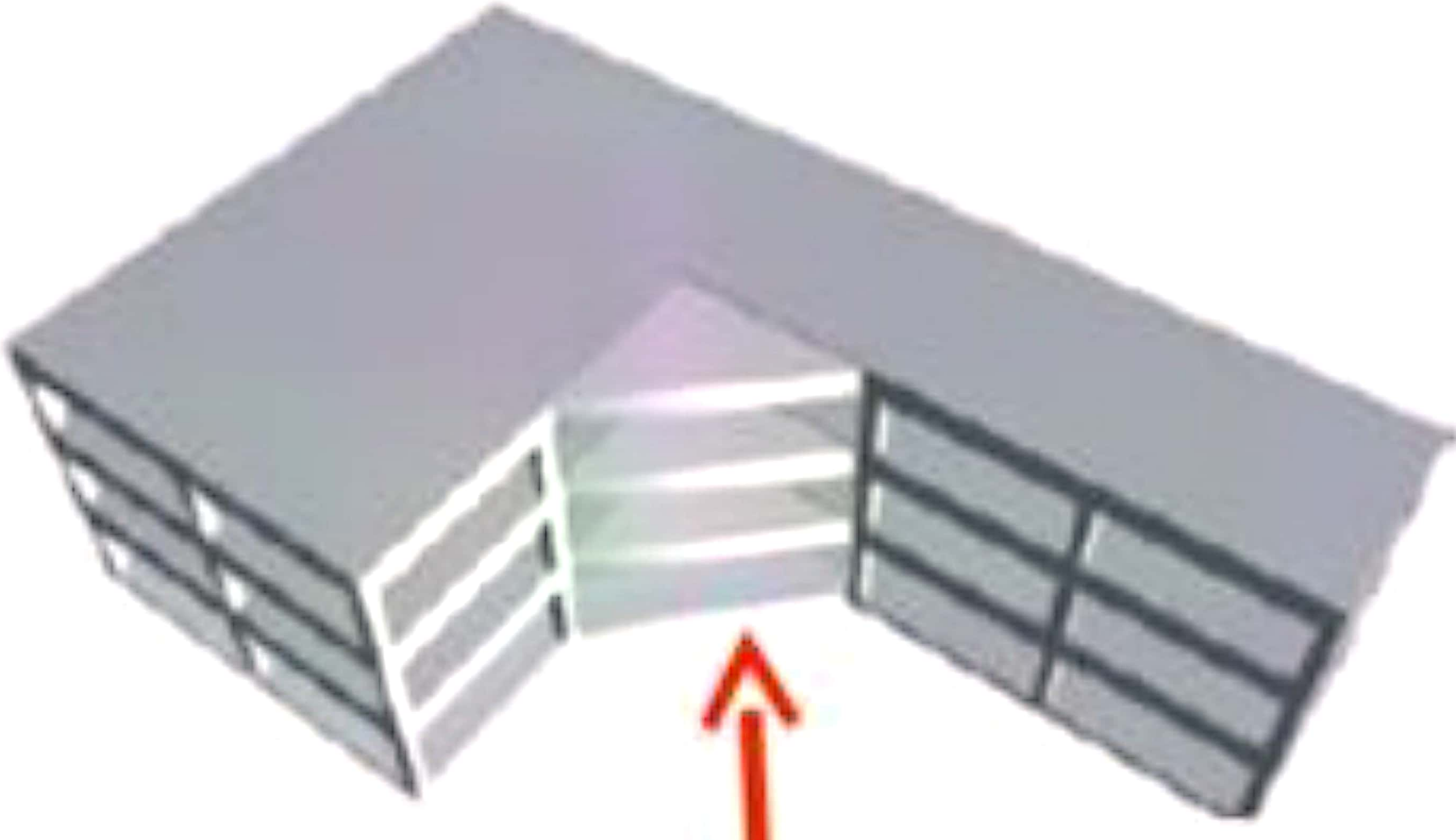
(3) **Use of splayed:-** Another possible solution is the use of splayed rather than right angle re-entrant corners lessens the stress concentration.



Seperation

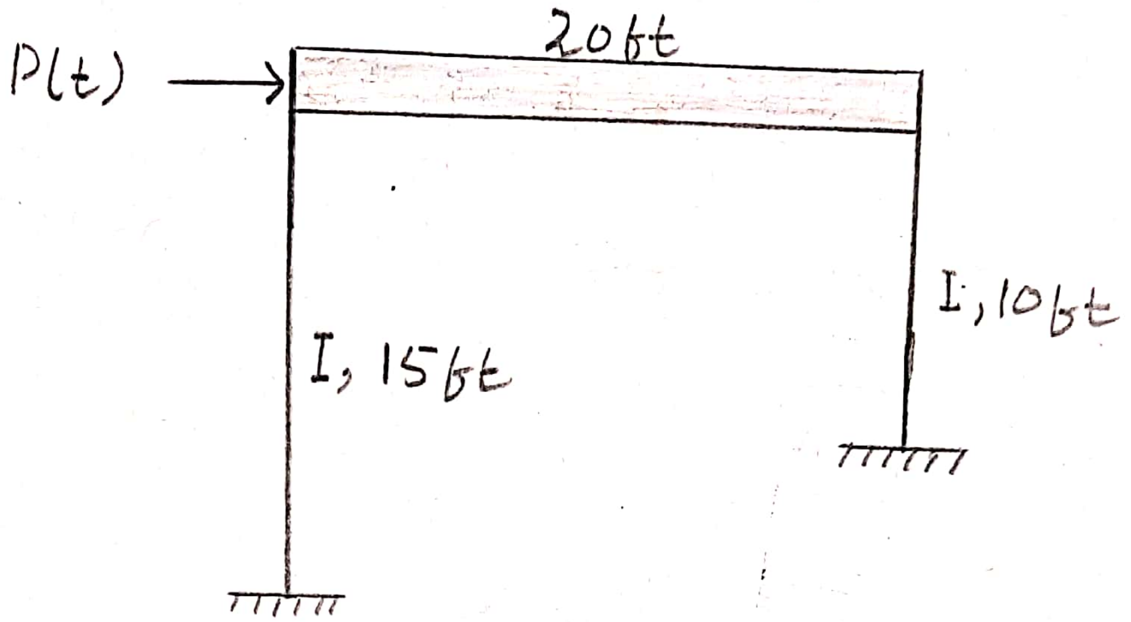


Stiff resistant elements



Splayed re-entrant corners

Q: 2



Given Data:-

Modulus of Elasticity, E = 29,000 ksi
Moment of Inertia, I = 1200 in⁴.
Uniformly Distributed Gravity load = 7683 lb/ft.

Required Data:-

Develop Equation of motion = p(t) = ?

Solution:-

As,

$$k_{eq} = k_1 + k_2$$

$$\Rightarrow \quad k = 12EI\left[\frac{1}{h_1^3} + \frac{1}{h_2^3}\right]$$

$$k = 12 \times 29{,}000 \times 1200 \times \left[\frac{1}{(15\times12)^3} + \frac{1}{(10\times12)^3} \right]$$

$$k = 313.29 \text{ k/in}$$

$$\boxed{k = 3759 \text{ k/ft}}$$

Also,

$$m = \frac{w}{g} = \frac{7.683 \times 20}{32.2 \text{ ft/sec}^2}$$

$$= 4.772 \text{ k.sec}^2\text{/ft}$$

$$\boxed{m = 4772 \text{ lb.sec}^2\text{/ft}}$$

Now using D-Alembert's Principle of dynamic equilibrium.

$$P(t) = ku + m\ddot{u} \quad \text{— (1)}$$

As, $k = 3759 \text{ k/ft} = 3.759 \times 10^6 \text{ lb/ft}$

Putting values in eq (1),

$$\Rightarrow \boxed{P(t) = 3.759 \times 10^6 u + 4772 \ddot{u}}$$

where u and $P(t)$ are in ft and lb, respectively.